THE EFFECT OF CO-FIRING LARGE AMOUNTS OF SECONDARY FUELS ON SCR DEACTIVATION

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In the near future all the coal-fired boilers in the Netherlands are likely to be equipped with SCR to reduce NO_x emissions to acceptable low levels. On the other hand the co-firing of secondary fuels will be extended too, because, in the case of biomass, this will reduce the CO_2 emission from coal firing, which is part of an agreement between the power plants and the Dutch government. However, at the moment the knowledge about deactivation of catalysts in a high-dust SCR installation as a consequence of co-firing large amounts of secondary fuels in a coal-fired boiler is limited.

This year (2003) KEMA has started, in co-operation with Dutch Power Generation Companies and subsidised by the Dutch government, a research programme to obtain information about how the co-firing of secondary fuels affects the activity of SCR catalysts. In this research programme, samples of (high-dust) SCR catalysts from four catalyst companies are directly exposed in the flue gas channel of a full-scale 520 MW_e coal-fired power station. In this power station relatively high percentages of more than 10 weight-% of secondary fuels will be co-fired, such as MBM (meat and bone meal), demolition wood, RDF (refuse derived fuel) and sewage sludge.

During a 1.5-year period, catalyst samples will be exposed and sampled, and activities will be determined. Besides, from surface analysis of the catalysts, it will be assessed what has been the major cause of the deactivation. A special sample holder was designed to expose a large number of samples from each company at the same time. This sample holder will be placed in the flue gas between the economisers of the boiler at temperatures between 325 and 370 °C.

The most reliable way to assess the risk of co-firing on the SCR catalyst's deactivation rate is the above-described direct measurement of exposing catalysts in the flue gas of boilers in which co-firing takes place. However, this is costly and will take time because the deactivation has to be followed during a period of several months up to a year.

A relatively simple and quick way to assess the SCR catalyst's risk of extra deactivation when co-firing secondary fuels is to calculate the flue gas composition just in front of the SCR installation. By comparing calculated results in cases with and without co-firing, an indication can be given on the risk of deactivation. For example, if the concentration of a poisonous compound in the flue gas increases, it can be expected that the catalyst's deactivation also increases. The feasibility to assess the risk of deactivation by calculation is also part of the research project.

Focusing on poisonous components, calculations were done with the program FactSage™. This program can be used for calculating the thermodynamic equilibrium of complex mixtures of elements and compounds, also between different phases. The composition of the flue gas was calculated for the co-firing of four different secondary fuels, waste wood, RDF, poultry litter and meat and bone meal when co-firing these secondary fuels at 0, 12.5 and 25% e/e with coal.

The results show that the concentration of gaseous potassium and sodium increases more than proportional with the amount of co-fired RDF, poultry litter and meat and bone meal. These alkali metals are known for their poisonous effect when getting in contact with the active sites on the SCR catalyst. Therefore, an increase in deactivation rate can be expected when co-firing these fuels. An extreme increase in deactivation rate can be expected when co-firing 25% e/e of poultry litter, because the gaseous concentrations of sodium and potassium also increase dramatically.

The relatively large amount of phosphor present in poultry litter and bone and meat meal does not seem to contribute to the increase in the deactivation rate, since the concentration in the gas phase does not increase.

A slight increase in deactivation of the SCR catalyst may be expected from co-firing demolition wood. Although the concentrations of lead and zinc in demolition wood are much higher than those in coal, they hardly increase in the gas phase. However, because lead mainly exists in the gas phase down to 750 °C, it will preferentially condense on the outer surface of fly ash. Therefore, lead is readily available for transfer from fly ash to the SCR catalyst during contact.

Although an increase in deactivation can be predicted from calculations, it is not possible to estimate the exact deactivation rate and how it will affect the catalyst's lifetime. It is expected that this becomes clear when the calculations can be compared with the practical measurements of catalysts that have actually been exposed to flue gas of the coal-fired power plant in which co-firing takes place. Correlations that will be derived from practice (deactivation rate, results of surface analysis, fuel composition) and from the calculated flue gas composition during the exposure period, are expected to help to predict the catalyst behaviour quantitatively in various fuel compositions.

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